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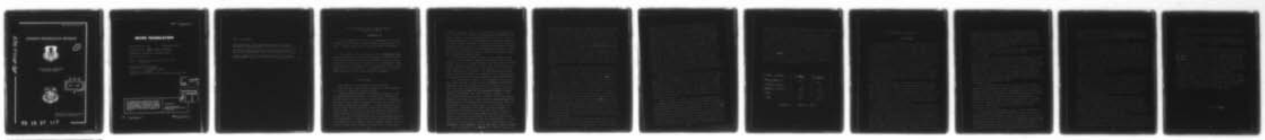

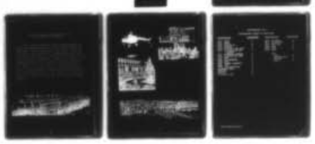

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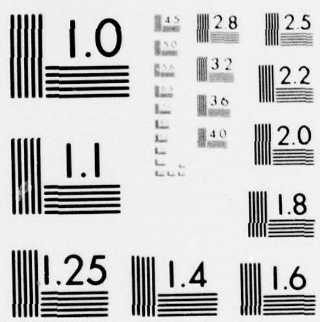

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FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

AERONAUTICAL KNOWLEDGE
(SELECTED PAGES)

FOREIGN TECHNOLOGY DIVISION

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The Association of Man and Machine Design in Aircraft Planning

Cheng Bu Shi

In the planning of aircraft, the association of man and machine design is always a major problem. This article will make a quintic distinction as an introduction for everyone.

Many machines need to be developed with originally stipulated abilities, the means of manipulating their "men" along with their composition makes for an effective working system. When designing this type of machinery you cannot consider only the aspects of "materials", you must still consider the association of man and machinery. The association of man and machine design is always a major portion of planning.

Introduction

How about the way an aircraft should operate?

This not only belongs to the problems of pilot training, it is also a problem of aircraft design.

Aircraft characteristics are constantly advancing, each day manipulation has a tendency to become more complicated, however, for the physiology and special points of physiology of the people that operate the aircraft, there have not been any conspicious variations discovered. In flight accidents a lot of the reasons for the accidents evolve from "error in pilot manipulation". For example, Japan has compiled statistics on flight accidents that have occured in a ten year span. Of these, 60.9% of the accidents were due to "manipulation errors", see Illustration 1. Should the blame be placed on the inadequate quality of the training process, thereby causing many unqualified pilots to be trained, or should it be due to defi-

ciencies in aircraft design in which the design required that the reactions of the pilot be better than the abilities of the normal person? The manipulation ability of man has some objective limitations. When operation of the aircraft requires more complication, surpassing the range of one man's normal abilities, then the number of personnel that manipulate the aircraft should be increased, the operation of it should be carried out jointly, or the automated equipment increased, reducing individual responsibilities.

The normal manipulation ability of man, firstly, is the ability of man to receive sensitive information from the machine, next, it is the consideration given this received information, enabling the ability to react with the proper type of manipulation, and lastly, it is the ability of man to physically manipulate the machinery. As man receives this information, thought reaction, and performing these manipulations--these three segments, all have definite objective limitations.

Some people have already, for a particular year, analyzed the serious dangers of near-accident occurrence, it has been discovered that the majority of them were mistakes on the pilots part in the interpretation of the instruments, and that these obstacles occurred in the associated segment of pilot receiving information from those operating aircraft. The many mistakes that lie here can be reduced or avoided through redesign. For example, 40 times mistakes occurred because interpretation of the instruments was too complicated (like the instrument dials with three needles), 24 sight errors were because of 2 instrument dials having similar exteriors, 25 were because of instrument malfunction, however, none were found to be because the instruments were already broken, 5 times it was because no attention was paid to warning lights and/or because the warning lights were malfunctioning. If the design can be sufficiently improved, the probability of a reoccurrence of the mistakes, for the most part, could be avoided.

When the aircraft is in take-off or in landing stages, the

pilot must repeatedly watch the environment of the cabin exterior and the instruments of the cabin's interior, at this time, if he is required to perform certain manipulation movements, the majority of which require the pilot to use his hands relying on memory, such as to reach out and sense the touch of the hand toggles. Some of these have to be pushed, others have to be pulled, some have to maintain their original position, they cannot be moved. If the position of the hand toggles is very close to each other, and the toggles are of similar shape, then it would be very easy to make a mistake. After this an accident could occur by the inadvertent retraction of flaps instead of the retraction of landing gear in flight. These various mistakes are manifested in the associated segment of man to aircraft.

No matter how many complicated improvements of technical science, the most unresolved problem is still the use of man as a control. Due to this, in construction design, especially in many large scale complicated projects, the entire design should always rely on the problem of association of man and machine. For example, the association of man and machine as mentioned, in the design of control towers for airports, the design of radar alert nets, the design of the room of operations in cosmic space ships, the design of ground surface control centers as well as large model electronic computers, etc. In aircraft design, determinations are made for the smallest number of people in the flight crew, the division of labor among the personnel of the flight crew, the design of basic manipulation form, design of the various functional positions for the body of each instrument and fixed dispositions for manipulation of hand toggles, fire control systems, high altitude lifesaving systems, etc. They all belong to the problem of design for man in association with machine.

Several thousand years ago when our country erected city walls, the design of the form of the wall as well as the size of the bricks was based on human dimensions, enabling the sol-

diers who guarded the walls to conceal their own bodies, and moreover, they could fire arrows to the outside. It even went to the point of determining the dimensions for the bows, and it had to consider the length of a man's arms and the strength of his arms. Since ancient times, the majority of construction projects have all taken into consideration the human factor. This type of consideration generally has not created any kind of special difficulties. Following the increasing scale of work projects and their complicated changes, the problem of man and machine association has been brought out. After the Second World War, jet technology, atomic energy, rockets, radar, and electronic computers were all developed and utilized, enabling mankind to create an expansion of natural powers, the large model, complicated levels of construction projects manifested in short order, the association of man and machine in design gradually became the most important major problem of design theory in these construction projects.

The association of man and machine design is always a major problem in planning, because in the design of every construction project, whether or not it is designed entirely for originally stipulated characteristics, to a very great extent, is determined by whether or not it is good for the association of man and machine. If the hidden characteristics of an aircraft are excellent, but, in design, the association of man and machine is lacking, then it cannot be manipulated, and, in that case, it is useless.

There are many specialties within the association of man and machine, sometimes they are called "physiological science of construction engineering" and "psychological science of construction engineering", recently countries abroad have called it the "human factor of construction engineering", from the design of construction projects, the aspect of man's association with machines has pointed to every type of physiological and psychological factor in man. In this sense, there are a series of specialized problems, like the suitability of manipulation sequence,

reaction time, the most suitable arrangement of the instruments, the sufficient locus of movement of the eyes for men carrying out their mission, muscle control, eye control, the power of the sense organs to feel, etc. In addition there are types of research that also possess a major significance, such as researching man's decision thought process, researching the usefulness of man inside things, and the decision process of refusing or acting on these two values within, etc., in order to be able to replace a large portion of man's work with automated equipment. People should wholeheartedly pay attention to the relevance of research in man's association with machinery, and in planning of engineering projects executing an excellent design of man machine association.

CAUSE OF ACCIDENT	OCCURRENCE	PER CENTAGE
Pilot manipulation errors	220	60.9
MAINTENANCE ERRORS	8	2.2
Mechanical deficiencies	48	13.3
Others	85	23.6
Total	361	100.

Illustration 1 - Statistical Chart

The Layout Pattern of Aircraft Main Assembly Production Lines

Lin Yi Ping

Final assembly of the aircraft is the last stage in the process of making aircraft. The special points of this stage are; it is the greatest amount of work, mechanized procedures are at a minimum, many systems are manually operated, moreover, there is a limited surface area for work. In order to logically use the amount of surface area in the aircraft main assembly hangar, the total assembly force has to be kept at a minimum, and shorten the assembly time frame, then you will have an excellent arrangement of the assembly line for production of aircraft.

To insure the shortest time frame for assembly it requires a series arrangement of the maximum possible number of aircraft parts in the production line for the main assembly of aircraft and is arranged in a fixed parameter according to the surface space of the hangar.

People always visualize an aircraft main assembly production line as being in a straight line, moreover, as a flowing line. However, when there is a straight line type production line for mass assembly, a long, extending line is formed, and often it is restricted by the linear dimensions of the hangar, the series arrangement does not allow for much aircraft equipment, in this manner it has compelled people to select the revolving type production lines as a resolution.

Speaking in regards to the fixed type aircraft production, the amount of aircraft equipment can be arranged in a series for a given production line of mass assembly is determined by the total occupied surface area, the passageways, and the surface area occupied by the equipment that is used for assembly in the main assembly hangar; when assembling these, a portion of the elements used have to have storage space, the work activity space for the personnel along with the area that each aircraft occupies, as well as other determinants. However, due to the contin-

ous changes and improvements of the aircraft, even newer, its exterior geometric dimensions change at random, like the wings being lengthened and the fuselage being shortened, etc., therefore, in order to have a suitable main assembly process for the new type aircraft, we must alter the layout pattern of the aircraft main assembly production line.

Inserted on this page, we have brought out six types of aircraft main assembly production line layout patterns.

COLUMNAR PATTERN

It is suitable when the wingspan of the aircraft to be assembled is less than or very near to the width of the enclosed area for the main assembly production line. It's special features are that each aircraft to be assembled is arranged in a straight line head to tail, to make a work area of this type, it is easy to arrange them in a series, it is an attractive sight, it is convienent to move each aircraft, and the entire production line moves with ease, however, the corresponding number of aircraft to be assembled is comparatively small.

HORIZONTAL PATTERN

This is suitable for use when the length of the aircraft that is to be assembled is nearly equal to the width of the enclosed area of the main assembly production line. It's special features are that each aircraft is separated according to a predetermined interval perpendicular to the production line. To use this area in said manner, the series arrangement is attractive and the corresponding number of aircraft to be assembled that can be arranged in series is comparatively greater.

NEIGHBORING HEAD PATTERN

It is the most economically arranged type of columnar pattern. It's special features are that both heads of a pair of aircraft are in a consecutive series, the objective is to reduce the occupied surface area, it is a good arrangement for even more aircraft to be assembled. This type of pattern is suitable when the wingspan and the distance between the forward portion of each aircraft is less than the width of the enclosed area of the

main assembly production line. However, when aligning them in a series such as this, you have a greater time expenditure, movement for the entire production line is inconvenient and the work area for the neighboring heads is insufficient.

TAB EDGE PATTERN

It is the most economical type of horizontally arranged series. The special characteristics are that the forward edge of an aircraft wing and the wing tabs of a neighboring aircraft are interphased, but it requires the reservation of specific work areas to be used for assembly. This arrangement enables a reduction in the space occupied by the pair of aircraft to be assembled, allowing arrangement for an even greater number of aircraft to be assembled. It is especially suitable for assembling short echelon wing types, small wingspan, and small crescent type wings as compared to the swept-back wing aircraft.

FRONT EDGE INTERPHASE PATTERN

It's special features are that the forward edge of the aircraft wings of a pair of aircraft to be assembled are in close proximity, moreover, they are arranged in a horizontal series. This pattern is of an adaptable, spacious nature, not only is it suitable for level winged aircraft, it is even further suitable for use with the triple wing aircraft, and large type crescent wing aircraft as compared to the swept-back wing aircraft.

REAR EDGE INTERPHASE PATTERN

It's special features are that the rear edge of the aircraft wings of a pair of aircraft to be assembled are in close proximity, moreover, they are arranged in a horizontal series. This type of pattern is only suitable for the large crescent type aircraft as compared to the level winged and the swept-back winged aircraft in assembly line arrangement, but is not suitable for the triple wing and short echelon wing aircraft.

The last two types of patterns are both for the reduction of surface area that the aircraft to be assembled occupy, the arrangement is to facilitate a comparatively greater number of aircraft to be assembled. However, for these two types of arrangement,

the consumption of time is great, movement of the main assembly production line is inconvienent, and work space is relatively small.

From the aforementioned it can be ascertained that the type of pattern for the main assembly production line cannot be of a random arrangement, but must be determined by the actual conditions of production.

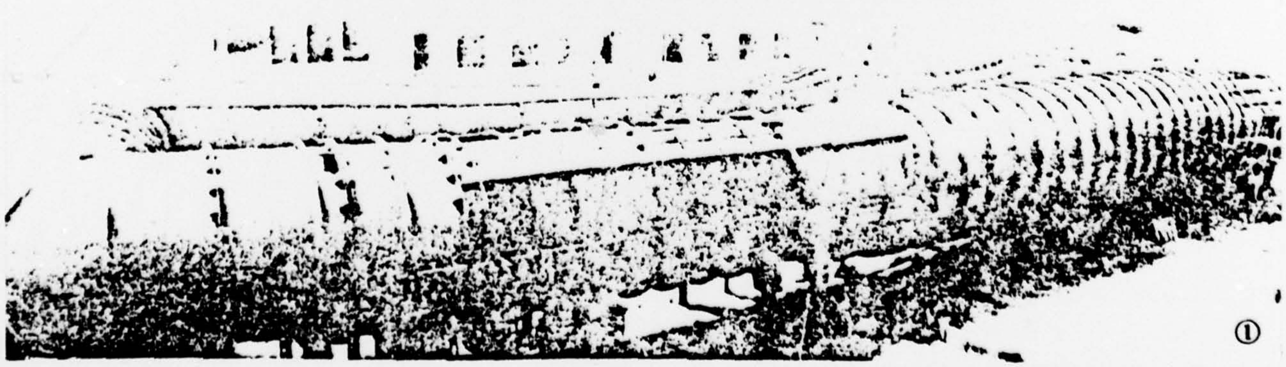
Aircraft main assembly production lines are always in close proximity to a central storage depot and workshops, with each element for assembly. This can minimize the amount of transport, the (work) cycle, the waiting time for materials, and makes it convenient to have parts, the elements in the workshop and the central storage depot are kept as spare parts, components, elements, parts-purchased-outside, and collaborating elements (including generators, electrical equipment, radio instruments, and armament, etc.) for use in the assembly of aircraft.

Following the continous application for developing aviation science technologies along with the electronic computers in the aviation industries, the method of aircraft main assembly cannot just stop in mid-stream, it will definitely have it's various advancements and will inevitably realize new and even more adaptable layout patterns for the production lines.

Graphics: Li Jia

Cut-out Silhouettes of Our Country's Top Level Aviation Institutions

BeiJing Aviation Institute, XiBei Industrial College and NanJing Aviation Institute are the three major top-level Institutions of Aviation Technology in our country. These three have already been introduced in a publication of May of this year. Now we will publish a few reproduced photographs of their student instruction activities. Picture 1 is of Nan(Jing) Aviational Aerodynamic Force Learning Systems and a Low-Speed Wind Tunnel; 2 is of a test flight of a helicopter built by the students and teachers of NanJing; 3 is Xi(Bei) Industrial College professor lecturing (upperclassmen); 4 is the grounds of the Xi(Bei) Industrial College with a view of the College Library; 5 is a bird's eye view of the area of BeiJing Aviation Institute.



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